DOCUMENT RESUME

ED 480 229 CS 512 376

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TITLE	Critical Issue: Using Technology To Enhance Literacy Instruction.
INSTITUTION	North Central Regional Educational Lab., Oak Brook, IL.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE	2001-10-00
NOTE	19p.
AVAILABLE FROM	North Central Regional Educational Laboratory, Editorial Offices: NCREL, 1120 E. Diehl Rd., #200, Naperville, IL 60563. Tel: 800-356-2735 (Toll Free). For full text: http://www.ncrel.org/ sdrs/areas/issues/content/cntareas/reading/ li300.htm.
PUB TYPE	Guides - Non-Classroom (055) -- Opinion Papers (120)
EDRS PRICE	EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS	*Computer Literacy; Curriculum Development; Elementary Secondary Education; *Information Literacy; *Media Literacy; Professional Development; Reading Instruction; *Technology Uses in Education
IDENTIFIERS	*Critical Literacy

ABSTRACT

Noting that technology has contributed to an expanded understanding of literacy, this guide offers research, best practices, and resources that support the integration of new technologies into literacy instruction. It begins with brief definitions of: information literacy, digital literacy, new literacy, computer literacy, computer-technology literacy, critical literacy, and media literacy. It discusses research on technology and literacy, and outlines technologies that support students' reading development and research and collaboration skills. In discussing professional development in technology and literacy, it notes that as educational technologies move the classroom toward a student-centered model, the role of the literacy teacher becomes that of a coach, facilitator, or mentor. The guide lists the following goals related to technological literacy: the school or district has a clear set of goals, expectations, and criteria for improvements in student literacy; educational technology supports literacy instruction in the classroom and is integrated into the literacy curriculum; all students have opportunities to use educational technology to improve their literacy skills; and ongoing professional development in literacy and technology provides educators with current and practical applications for enhancing students' literacy skills. Action options for teachers, library-media specialists, parents, and community members; implementation pitfalls; illustrative cases, and a list of contacts are provided. (PM)

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Critical Issue: Using Technology to Enhance Literacy Instruction.

By Ann Holum, Ph.d. and Jan Gahala, M.A.

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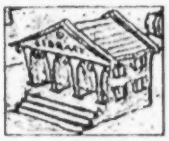

Critical Issue:
Using Technology to Enhance Literacy Instruction

This Critical Issue was coauthored by Ann Holum, Ph.D., and Jan Gahala, M.A. Holum's doctoral work on the use of interactive media to improve children's story-understanding skills sparked her ongoing interest in integrating technologies in K-12 literacy settings; she currently is an independent educational consultant. Gahala is a technical specialist in NCREL's Communications department.

ISSUE: Educational technology is nudging literacy instruction beyond its oral and print-based tradition to embrace online and electronic texts as well as multimedia. Computers are creating new opportunities for writing and collaborating. The Internet is constructing global bridges for students to communicate, underscoring the need for rock-solid reading and writing skills. By changing the way that information is absorbed, processed, and used, technology is influencing how people read, write, listen, and communicate.

Although technology promises new ways to promote literacy, educators' reactions to it have been mixed. Some have embraced technology with unbridled enthusiasm while others have held it at arm's length with a healthy skepticism. Yet the growing influence of technology has caused many educators to acknowledge that they need information on teaching literacy skills in the Digital Age. To serve that need, this Critical Issue offers research, best practices, and resources that support integration of new technologies into literacy instruction.

Overview | Goals | Action Options | Pitfalls | Different Viewpoints | Cases | Contacts | References

OVERVIEW: Literacy instruction traditionally refers to the teaching of basic literacy skills—reading, writing, listening, and speaking. In today's digital world, however, technology has contributed to an expanded understanding of literacy. Besides having basic literacy skills, today's students also need technology skills for communicating, investigating, accessing and using information, computing, thinking critically about messages inherent in new media, and understanding and evaluating data. As policymakers and educators ponder what it means to be literate in a digitized society, an array of literacy definitions is emerging. Among them are the following examples:

- **Information Literacy:** The ability to access and use information, analyze content, work with ideas, synthesize

thought, and communicate results.

- **Digital Literacy:** The ability to attain deeper understanding of content by using data-analysis tools and accelerated learning processes enabled by technology.
- **New Literacy:** The ability to solve genuine problems amidst a deluge of information and its transfer in the Digital Age.
- **Computer Literacy:** The ability to accurately and effectively use computer tools such as word processors, spreadsheets, databases, and presentation and graphic software.
- **Computer-Technology Literacy:** The ability to manipulate the hardware that is the understructure of technology systems.
- **Critical Literacy:** The ability to look at the meaning and purpose of written texts, visual applications, and spoken words to question the attitudes, values, and beliefs behind them. The goal is development of critical thinking to discern meaning from array of multimedia, visual imagery, and virtual environments, as well as written text.
- **Media Literacy:** The ability to communicate competently in all media forms—print and electronic—as well as access, understand, analyze and evaluate the images, words, and sounds that comprise contemporary culture.

Edyth E. Young, Ph.D., NCREL program director/research, Center for Literacy outlines "Content Literacy"
[QuickTime Video and text, information about QuickTime is available].

For additional information on digital-age literacy and skills that students will need to effectively function in today's world, refer to 21st-century skills.

Whether these new definitions of literacy will evolve new curriculum, crystallize into an enhanced general definition of literacy, or spawn offshoot subjects taught under the umbrella of literacy instruction is not yet clear. But most educators today agree that literacy instruction, at minimum, should include computing skills. Other forward-looking educators see a greater role for technology in the literacy classroom; they believe that technology has the potential to connect students to reading and writing. Meyer and Rose (2000), for example, point out "the potential of new technology to revitalize reading instruction and to make reading more relevant to the lives of children growing up in the Electronic Age." Bruce and Peyton (1999) state, "Teachers can use network-based approaches to literacy instruction to support authentic reading and writing, collaboration, student-centered learning, writing across the curriculum, and the creation of classroom writing activities."

Questions raised by educators as they consider integrating technology into literacy instruction focus on three specific areas: research, practice, and professional development.

- **Research:** What empirical evidence exists to confirm that new technologies can be effective in support of literacy instruction? What technologies actually improve literacy programs? What technologies have little or no effect? Are any technologies, in fact, harmful to development of successful literacy instruction?
- **Practice:** Precisely which technologies, to date, are being used successfully to support literacy instruction?

What technologies hold promise for the future? How are teachers integrating them into literacy instruction?

- **Professional Development:** How has professional development in literacy-based contexts been influenced by the advent of educational technologies? What skills do teachers need for integrating technology into literacy instruction?

Research on Technology and Literacy

Educational researchers and practitioners alike assert that the potential of new technologies for learning is likely to be found not in the technologies themselves but in the way in which these technologies are used as tools for learning (Means & Olson, 1995; Owston, 1997; Valdez et al., 1999). In literacy instruction, technology has both traditional and authentic uses (see Singh & Means, 1994). A traditional use of technology is skills reinforcement; for example, students who need additional practice in reading might work individually on computers equipped with reading-comprehension software. An authentic use of technology is using it as a tool to accomplish a complex task; for example, students who are creating a written report might use the Internet for research, word-processing software to write and format the text, and hypermedia software to add images. Therefore, it makes sense to consider the variety of uses as they illustrate best practices.

Although many reviews of empirical studies and volumes of observations relate to the use of new technologies in support of literacy education (see Kamil, Intrator, & Kim, 2000; Leu, 2000), two challenges emerge when educators look for evidence that might anchor recommendations for using technologies in literacy instruction. These challenges are the "moving target" problem that is inherent in the subject being researched, and the scarcity of comprehensive literacy studies offering informed commentary.

The "Moving Target" Problem. Much of the evidence that the researchers have been able to generate with regard to educational technologies is about innovations that aptly are described as a "moving target" (Valdez et al., 1999, p. 1). In other words, even as researchers begin to describe empirical evidence supporting the effects a particular technology on an educational practice, that technology itself is changing and in some cases even becoming obsolete. In addition, the evolving nature of educational technologies precludes any efforts to predict the success of, and establish guidelines for, subsequent educational practices. "As newer technologies of information and communication continually appear, they raise concerns about the generalizability of findings from earlier technologies," notes Leu (2000). "It is important to be cautious about generalizing findings from traditional texts to different forms of hypermedia because each technology contains different contexts and resources for constructing meanings and requires somewhat different strategies for doing so" (p. 749).

Scarcity of Comprehensive Literacy Studies. Not only does technology change faster than guidelines for innovations can be established, but relatively few thorough studies have evaluated the efficacy of new technologies for literacy education. For example, a review by Kamil and Lane (1998) examined literacy research during the years between 1990 and 1995. (For a discussion, see Kamil, Intrator, & Kim, 2000; Leu, 2000.) This review looked at four mainstream literary journals with the highest citation rates for literacy research: *Reading Research Quarterly*, *Journal of Reading Behavior* (since changed to *Journal of Literacy Research*), *Written Communication*, and *Research in the Teaching of English*. In the two reading journals, only 1 percent of the articles dealt with technology issues. In the two writing journals, only 5 percent of the articles dealt with technology issues. In summary, Kamil and Lane (1998) note, "Research into the problems and processes of literacy and technology has advanced little beyond what it was 10 years ago" (p. 338).

Some researchers suggest that the challenges related to technology and literacy must become more integral to mainstream literacy research. Collins (1992), for example, suggests that research should shift from an emphasis on

traditional summative evaluation (in which data is acquired at the end of an activity) to include more formative design approaches (which are informed by data acquired during the planning and development of the activity). In fact, the formative-design experiment approach—in which research questions focus on the resources needed to make a specific implementation succeed (see Reinking & Watkins, 1996)—is likely to become a trend in future educational research. As Kamil and Lane (1998) comment, "It is too late to ask questions such as whether we should allow students access to the Internet. Rather, we should be conducting research that asks questions such as, 'What does it take to use Internet connections successfully in teaching literacy?' " (p. 339).

Some educators believe that schools should provide students with exposure to current technologies used in the business world regardless of whether those technologies have been proven effective through research. Leu (2000) states, "It may become unimportant to demonstrate the advantages of new technologies for educational contexts if it is already clear those technologies will define the literacies of our students' futures" (p. 762).

Technologies That Support Students' Reading Development

Educational technologies that support the development of students' reading skills include audiobooks, electronic books and online texts, electronic talking books, and programmed reading instruction.

Audiobooks. Audiobooks, sometimes known as *books on tape*, are professionally recorded, unabridged versions of fiction or nonfiction books. They are available on regular audiocassettes or four-track cassettes that require a special cassette player. Audiobooks promote students' interest in reading and improve their comprehension of text, notes Beers (1998). They also have been used successfully by students who cannot read traditional printed books because of visual or physical handicaps.

When used in conjunction with written texts, audiobooks help improve children's reading skills. Children can listen to the audio version of a book and follow along silently with the printed version. Also, they can gain practice in reading aloud the text in conjunction with the audio. "Hearing text read aloud improves reading ability," states Beers (1998). "The use of audiobooks with struggling, reluctant, or second-language learners is powerful since they act as a scaffold that allows students to read above their actual reading level. This is critical with older students who may still read at a beginner level."

Electronic Books and Online Texts. Electronic books, also known as *e-books*, are electronic texts that are presented visually. Whether available on CD-ROM, the Internet, or special disks, electronic books always provide the text in a visual component. Some electronic books incorporate text enhancements, such as definitions of words or background information on ideas. Others offer illustrations that complement the story. The downside of electronic books is that they can be viewed only with a computer or a special palm-sized digital reader; often the text resolution is poor. In terms of their advantages, Anderson-Inman and Horney (1999) note that electronic books are searchable, modifiable (for example, font sizes can be increased to meet the needs of the reader), and enhanceable with embedded resources (for example, definitions and details).

Online texts are those that are available on the World Wide Web. With access to an Internet-connected computer, students can find a wide variety of free online reading materials, including books, plays, short stories, magazines, and reference materials. This benefit is especially useful for students in schools that have few resources for the acquisition of new books.

Electronic books and online texts often are equipped with *hypermedia*—links to text, data, graphics, audio, or video. As students read the text, they are able to click on the links to access definitions of words, additional information on concepts, illustrations, animations, and video—all of which can increase their understanding of the material. Research

indicates that hypermedia software has positive effects on student learning and comprehension (see Anderson-Inman & Horney, 1998; Anderson-Inman, Horney, Chin, & Lewis, 1994; Hillinger, 1992; Hillinger & Leu, 1994; Leu & Hillinger, 1994).

The use of hypermedia to improve student comprehension of text likely is related to its ability to respond to the needs of an individual learner for information, which results in an increased sense of control over the learning environment and higher levels of intrinsic motivation (Becker & Dwyer, 1994). That is, the interactive features of hypermedia and the users' control of their direction within these information environments may explain some of the learning gains in comprehension (for a discussion, see Leu, 2000).

Electronic Talking Books. The term *electronic talking books* has been coined by some researchers to refer to electronic texts that also provide embedded speech. The speech component offers a digitized reading of general sections as well as pronunciations of specific words within the text; it supports and coaches students as they read the text of the story (Leu, 2000; McKenna, 1998). Although research is ongoing about the effectiveness of electronic talking books, there already is much to be said in their favor (for a review, see Leu, 2000; McKenna, 1998). "Computers, especially those equipped with devices that produce artificial speech, may provide an effective means for increasing decoding skills and reading fluency," note Reinking and Bridwell-Bowles (1966, p. 321).

McKenna (1998) notes that electronic talking books increase motivation to read as well as promote basic word recognition. According to some research, the use of talking books has shown positive results as an aid to help children improve their comprehension of texts (Hastings, 1997; Lewin, 1997; McKenna, 1998; Reitsma 1988). In addition, children's decoding skills have been shown to improve with the use of talking books (Miller, Blackstock, & Miller, 1994; Olson & Wise, 1992; Reitsma, 1988; Wise & Olson, 1994). For slightly older readers, talking books feature glossary entries, explanatory notes, and simplified rewordings that provide additional background information needed to understand new concepts in texts (Anderson-Inman & Horney, 1998).

In general, electronic talking books have been found to support reading instruction by providing background information, extended response actions, play actions, and explanatory notes. Talking books also show promise of accelerating reading growth by offering readers immediate access to a word's pronunciation—thus easing the need of the student to rely on context cues to understand new words. They also can be equipped with a tracking system for troublesome pronunciations; this system can provide feedback to teachers, enabling them to identify particular categories of words for further student study.

Programmed Reading Instruction. Various types of software programs, computer-assisted instruction, and integrated learning systems offer programmed reading instruction for students. This skills-based instruction ranges from letter recognition to phonics instruction to vocabulary building. A study by Barker and Torgeson (1995) also indicated that computer-assisted instruction is valuable in improving the phonological awareness of 6-year-olds. The computer program helped the children learn to discriminate and sequence the sound in words, which improved their word-reading ability.

Although programmed reading instruction was one of the first uses of technology in literacy instruction, this area is generating new developments as technology becomes more sophisticated. Recent developments in software programs for literacy instruction include voice-activated reading software and software for culturally mediated instruction. Project LISTEN is an example of research-in-progress on a computerized reading tutor; this software application "listens" as children read and "coaches" (talks) when the reader makes mistakes, gets stuck, clicks for help, or is likely to encounter difficulty.

Technologies That Support Students' Writing Development

Educational technologies that support the development of students' writing skills include word processing, desktop publishing, multimedia composing, online publishing, and Internet communication.

Word Processing. Word processing is the pioneer application of educational technology used in writing instruction. Although it requires the mastery of basic keyboarding skills, word processing allows many students to write and edit their work more easily. In addition, word-processing tools such as spelling checkers are useful aids that improve the quality of student writing. Research indicates that students who are comfortable with word processing write longer papers, spend more time writing and revising, and show improved mechanics and word choice (Lehr, 1995). Nevertheless, research also indicates that using a word processor does not by itself improve student writing. Rather, the teacher has a critical role in guiding the writing process, providing feedback, and encouraging revision (Reinking & Bridwell-Bowles, 1996).

The arguments for promoting word processing in K-12 education are several. First, some educators acknowledge that because of the prevalence of word processing in the workplace, students should be taught at least the rudiments of word processing, much the same way that students have learned typing skills and their related content-based counterparts such as organizing a term paper, composing a letter, or drafting documents for research in various subject areas. Today's comparison might extend that argument to include acquiring such skills to produce traditional documents as well as hypertext, interactive documents.

The general claim behind the need to shift from typing or pen-and-paper compositions to word processing is that the latter is more efficient, and therefore the offloading of the mechanics of writing by word processing will improve the quality of writing. Researchers have investigated these claims. A meta-analysis of 32 studies comparing two groups of students who received identical writing instruction—with one group using word processing for writing assignments and the other group writing by hand—found that the quality of writing was higher for students using word processing (Bangert-Drowns, 1993). These studies—which included various grade levels, from college and high school down to elementary—indicated that the greatest successes with word processing were at the higher grade levels. More recent research indicates that younger students also benefit from word-processing skills. A study of children's writing in a high-computer-access setting compared to a setting with infrequent usage, conducted during a three-year period beginning with third grade, showed that frequent use of word processing contributed to improved writing skills (Owston & Wideman, 1997). Another study of second-grade students indicated that word processing improved children's general writing skills and contributed to longer compositions (Jones, 1994).

Other researchers have tempered this finding by showing that without additional and appropriate structures for refining the quality of the writing, students' work does not automatically improve with word processing alone. For example, one researcher suggested that revisions of written work do not automatically result from the shift from pen-and-paper to word processing unless prompts for revision are explicitly added (Daiute & Kruidenier, 1985; Daiute, 1986). On the basis of this research, researchers strongly recommend that teachers actively adapt word-processing programs to instruction, thereby making an effective tool for learning.

The use of the computer for word processing also promotes collaborative writing among students. The computer screen enables students in small groups to see the writing that has been input, discuss its fine points, and make suggestions that will improve the quality. Wood (2000) notes that when using computers collaboratively "children worked together more than they normally would to write stories, search the Web, or create multimedia presentations" (p. 120).

Desktop Publishing of Student Work. An extension of word processing is desktop publishing, in which students learn to format text, plan the layout of pages, insert charts and graphics, and produce a professional-looking final copy. As students are mastering word-processing skills, they can gain practice in desktop-publishing their reports,

stories, and poems. Teachers also may require students to keep an electronic portfolio of their work, which can be printed at the end of the year and used to show improvements in each student's writing skills. Some classrooms enjoy writing and producing a class newspaper.

Multimedia Composing. Besides text-based writing, technology encourages students to integrate visual and aural multimedia in their school projects. Various software programs allow students to insert images, sounds, and video, thereby creating complex, multilayered compositions. For students who have difficulty with writing, multimedia composing presents a means of self-expression and provides support for development of reading and writing skills.

Online Publishing of Student Work. Providing opportunities for online publishing of students' work is another means to motivate student writing. "Publishing online is a motivating factor when completing classroom assignments," notes Karchmer (2000). "Students feel their work could have far-reaching effects, which in turn encourages them to put more effort into it" (p. 83). One way to accomplish online publishing is through the school's Web site. Classrooms often have their own Web pages, which can display student assignments and extracurricular writing. If a school does not have its own Web site, opportunities to develop and house a Web site can be found at The Collaboratory Project and Web66: A K-12 World Wide Web Project. These projects, sponsored by educational organizations and businesses, support the development of a school's Web site and offer to maintain the school's server. They also are based on the premise that many literacy teachers need additional technology support to publish documents online.

Online publishing also can be accomplished through online magazines and educational organizations that post students' writing on the Web. Three examples are Midlink Magazine, The Young Writers Club, and International Kids' Space. The World of Reading posts book reviews that are submitted by children.

Internet-Based Communication. Another way to promote student writing is through electronic mail (e-mail), electronic bulletin boards, and e-mail lists. Such Internet-based communication can be with peers, adults, or professional experts from around the world. Students in classrooms across the country can become online penpals (sometimes called *e-pals* or *keypals*). Some classrooms enjoy pairing up with older adults who live in retirement homes. Still another use is online communication with adult experts who have agreed to answer students' e-mail questions.

Writing to an authentic reader has a positive effect on students' writing performance and motivation (Reinking & Bridwell-Bowles, 1996). "Simple exchanges of e-mail can get students writing and reading with the same intensity they bring to the most exciting video game," note Meyer and Rose (2000). "Receiving feedback from across the globe conveys to young children the power of reading and writing and demonstrates their ultimate purpose—to communicate across time and space."

Technologies That Support Students' Research and Collaboration Skills

Technologies that support students' research and collaboration skills include Internet search engines, online tools for evaluating Web-based information, and Web sites that offer collaborative activities.

Internet Search Engines. The Internet has gained momentum as the infrastructure on which international knowledge is created and shared. Use of the Internet search engines can promote students' research and investigation skills and enable them to locate online information on any possible topic. Students also can access online journals, magazines, newspapers, encyclopedias, and informative Web sites. Unfortunately, some information on the Web is neither accurate nor reputable. Students need to learn how to evaluate this information.

Online Tools for Evaluating Web-Based Information. The need to evaluate online information sources is gaining importance as a basic literacy skill. Online tools for evaluating online information provide strategies for determining the accuracy, quality, and timeliness of online information.

Web Sites That Offer Collaborative Activities. Educational technology has expanded the instructional potential of collaboration. In the recent past, student collaboration in literacy activities might have meant one classroom joining with another classroom across the hall to engage in joint reading, writing, listening, speaking, or research projects. Today, educators can access and share a global curriculum-development lab with other educators. They can engage their class with another in literacy-based projects without geographic boundaries.

Although collaboration in itself does not necessarily promise to improve literacy skills or guarantee learning, it has proven to be a powerful motivation tool for students. Anecdotal evidence abounds from teachers who cite measurable improvements in reading, writing, listening, and speaking skills among students whose classroom walls have widened to embrace the global community. One Web site that offers collaborative learning projects with students worldwide is the Global Schoolhouse. Many of the projects focus on development of writing skills.

Professional Development in Technology and Literacy

Edyth E. Young, Ph.D., NCREL program director/research, Center for Literacy relates the professional impact of her first teaching position.
[QuickTime Video and text, information about QuickTime is available].

Requirements for professional development in literacy are aptly summarized by Leu (2000), who reflects on the rapidly changing nature of what it means to be a "literate" person in the 21st century:

> "Traditionally, we have selected teachers who were already literate and could pass their literacy along to our children. Now, however, the very nature of literacy is regularly changing because of new information and communication technologies. Many teachers literate in older technologies quickly become illiterate as newer technologies of information and communication replace previous technologies.... We must begin to develop strategies to help each of us keep up with the continually changing definitions of literacy that will exist in our world." (p. 763)

The importance of ongoing professional development in educational technology has been reiterated by researchers reviewing not only the needs of teachers of language arts and English but also those of educators across all curricular contexts (Means & Olson, 1995; Valdez et al., 1999). Leu (2000) notes the necessity of "staff development to continually support teachers as new technologies regularly appear" (p. 757). Many literacy educators feel the surge of new technology rumbling under their feet while they try to maintain a firm footing on the solid ground of basic reading, writing, and speaking instruction. The challenge is how to continue teaching traditional literacy skills while simultaneously learning new technologies and instructing their students in those technologies.

In general, teachers need ongoing, hands-on training in various literacy-based technologies. This training should enable them to become proficient in word processing, basic computer skills, e-mail, classroom conferencing, and electronic bulletin boards. It also should provide exposure to literacy software programs and computer-assisted instruction, electronic books, audiobooks, and multimedia composing. Of utmost importance is learning how to effectively integrate these technologies into literacy instuction. Other important components of effective professional development include adequate time, curriculum-specific applications, technical assistance and support, and a connection to student learning. (Refer to the Critical Issue Providing Professional Development for Effective

Technology Use.)

Peggy Grant, Ph.D, NCREL program associate/research, Center for Literacy talks about the challenge of a student-centered class.
[QuickTime Video and text, information about QuickTime is available].

As educational technologies move the classroom toward a student-centered model, the role of the literacy teacher becomes that of coach, facilitator, or mentor. In this model, responsibility for learning is shared as students engage in peer mentoring, reflection, and self-evaluation. The literacy curriculum in particular is likely to be a primary model for this situation because the skills of reading, writing, listening, and investigating lend themselves to self-development and peer work to reach measurable learning goals. Professional development in this context is likely to occur within the learn-by-doing venture.

Although numerous technologies currently are available to support the development of literacy skills, educators are wise to be aware of the strengths and weaknesses of each type. Future developments no doubt will continue to provide improvements in the quality and value of such technologies, but the value of traditional literacy instruction will remain. "Computers should and will play a major role in the reading classroom but will almost certainly not replace books or teachers. They will influence and perhaps even redefine traditional books, literacy, and the role of teachers, but all three will survive and thrive," state Meyer and Rose (2000). "Developing a clear-sighted, open-minded understanding of both old and new technologies will help develop a complementary relationship between them."

GOALS:

- The school or district has a clear set of goals, expectations, and criteria for improvements in student literacy.
- Educational technology supports literacy instruction in the classroom and is integrated into the literacy curriculum.
- All students have opportunities to use educational technology to improve their literacy skills.
- Ongoing professional development on literacy and technology provides educators with current and practical applications for enhancing students' literacy skills.

ACTION OPTIONS: Administrators, teachers, library-media specialists, and parents and community members can take the following steps to promote technology for enriching students' reading and writing skills.

Administrators

- Work with teams of teachers, parents, and community members to ensure that the school or district technology plan promotes the curricular goals of the literacy program. (Refer to the Critical Issue Developing a School or District Technology Plan.)

- Develop strategies for increasing the use of technology within the curriculum as it supports literacy-based teaching and learning experiences.
- Develop and make explicit to teachers, parents, students, and community members the district and schoolwide guidelines for the integration and use of new technologies within literacy programs.
- Refer to Learning to Read in the Computer Age, Computer Technology and Reading Instruction, More Than Words: Learning to Write in the Digital World, and Reading Programs That Work, and to learn about current reading and writing technologies and new technology applications in development.
- Develop firm policies prohibiting student plagiarism of online materials.
- Ensure that all students have equal access to literacy-based technology to improve their reading and writing skills. (Refer to the Critical Issues Ensuring Equitable Use of Education Technology, Using Technology to Enhance Engaged Learning for At-Risk Students, and Using Technology to Improve Student Achievement.)
- Become familiar with the evolving Technology Standards for School Administrators and participate in ongoing professional development in technology use.
- Review current research and best practice on technology and literacy. (A starting point is NCREL's Literacy Research and Best Practices.) Use those materials that best suit the needs of the district or school as springboards for professional development opportunities.

Teachers

- Participate in the development of the school or district technology plan to ensure that literacy goals are well-integrated throughout the plan.
- Be involved in discussions and selection committees to choose specific technologies and software that support the literacy curriculum.
- Become familiar with Standards for the English Language Arts, developed by the National Council of Teachers of English and the International Reading Association, and the Technology Foundation Standards for All Students, developed as part of the *National Educational Technology Standards* by the International Society for Technology in Education. Determine how these two types of standards can be used in conjunction to promote literacy and technology in the classroom.
- Consider technology tools as an extension of—not a substitute for—traditional literacy instruction in the classroom.
- Determine how electronic books can be used in the classroom.
- Besides integrating video and audio cassettes into literature programs, go beyond these resources to embrace newer technologies for enhancing literacy.
- Be aware of online lists of award-winning children's books that can be suggested to children for reading.

- Develop strategies for using microcomputers in elementary language arts instruction.
- Monitor and reinforce the literacy skills that students are learning through classroom software.
- Follow appropriate guidelines for computer-assisted reading instruction in the classroom.
- Use computer-assisted writing instruction to promote students' writing skills.
- Guide students' writing, provide feedback, and encourage word processing for revision in the writing process.
- Use electronic portfolios to collect students' writing assignments and document their improvements in writing.
- Provide opportunities for publishing students' work on the Internet.
- Search the NETS database of lessons and units for grade-specific reading and writing activities that integrate technology into literacy instruction.
- Gain practice in evaluating online educational materials for use in instruction.
- Become aware of the National Educational Technology Standards (NETS) for teachers and take steps to meet these standards.
- Participate in ongoing professional development on literacy and technology. Keep abreast of current realities as well as innovations, either through personal involvement in professional organizations that foster the understanding of technology and literacy across the curriculum, or through connections with computer-support personnel throughout the district.

Library-Media Specialists

- Help identify new technology and software for enriching students' reading and writing skills.
- Encourage school administrators to provide funds for the purchase of literacy technology and software.
- Provide information and support for teachers as they integrate literacy technology and software into their classrooms.

Parents and Community Members

- Provide children with access to technology and literacy in the home, at the local library, or through educational or not-for-profit community organizations.
- Become involved in parent organizations that foster an understanding of new technologies to promote children's literacy learning.
- Participate on the school or district technology planning team to help formulate or evaluate guidelines for the integration and use of new technologies within literacy programs.

IMPLEMENTATION PITFALLS: Educators may confront the following challenges as they try to integrate technology into literacy instruction.

When using word-processing software, students sometimes get carried away by the features of the software and forget that their real task is to write. They may spend much of their time selecting fonts, adding graphics and icons, and choosing backgrounds. To help students focus on their writing, the teacher may wish to turn off some of the software's available features.

Students who are unmonitored in their technology use may not reap real benefits in literacy. They need continued challenges and connections with the teacher to ensure that they are attaining higher-order thinking skills. Healy (1998), for example, warns that the activities offered on software programs often require only shallow processing and do not contribute to children's real learning. She notes that the act of watching a screen and making selections from limited options is "a pallid substitute for real mental activity" (p. 48). She adds,"We must make sure that computer use includes the important step of requiring children to 'elaborate' their knowledge—thinking aloud, questioning, communicating ideas, or creating some kind of original representation about what they are learning" (p. 141).

Peggy Grant, Ph.D, NCREL program associate/research, Center for Literacy suggests not ALL technology enhances learning.
[QuickTime Video and text, information about QuickTime is available].

Students who are working in small groups on technology-based projects may focus on some tasks to the exclusion of others. Although cooperative learning with computers has many benefits, Healy (1998) encourages teachers to promote students' individual participation in the processes of reading, writing, and reasoning. She notes, "With much hypermedia experience occurring as group work, those who choose not to read or write can often avoid these skills entirely by relying on the good readers and writers to do this part of the job" (p. 151). Teachers should monitor group processes to ensure that all children are participating in the reading and writing activities of each project.

In their zest to complete assignments, students unthinkingly may download, copy, and paste writing from the Internet directly into their school reports and projects. To prevent students from presenting someone else's materials as their own, schools needs to develop firm policies on plagiarism and ensure that students, teachers, and parents are aware of these policies. Also, teachers can help students learn to summarize, rephrase, and acknowledge another person's ideas.

Overemphasis on electronic texts may reduce children's use and enjoyment of printed books. A study by Gavriel Salomon indicates the importance of introducing children to books instead of relying only on electronic media. Salomon's study suggests that "children who learn in one medium (screen vs. page) will always be inclined to prefer the one in which they learned" (cited in Healy, 1998, p. 234).

Technology is most effective when it is used as an adjunct to traditional reading instruction. "A consistent finding from investigations of reading curricula is that brief, but regular, computer-based reading lessons can enhance reading achievement," note Reinking and Bridwell-Bowles (1996). "The results of these investigations, however, are based most often on the use of computer-based activities that supplement rather than replace conventional reading instruction" (p. 316).

Educators know the value of extending relationships beyond the confines of the classroom to connect with other

students and mentors worldwide. Few educators dispute that students are better motivated to read for comprehension and write to be understood when they are engaged in making real-world connections. But the value of these relationships is only as beneficial as the time and attention devoted to them. Whether within the confines of the classroom or on a worldwide basis, the development of connections requires the careful tending of savvy educators and interested students.

Electronic bulletin boards and e-mail correspondence create communication avenues for students, but those students require rules of the road. Unlike traditional communication avenues, such rules are works in progress. Educators need to help students become aware of the rules of online etiquette and appropriate forms of expression. Other important considerations include the acceptability of a fictitious identity, the role of self-regulation in public online forums, and the application of freedom of speech to all Internet interaction. Such considerations add a dimension to online communication that is both a challenge and an opportunity.

With thousands of programs and titles from which to choose, educators and library-media staff may need direction in selecting literacy software for students. Information on how to evaluate learning software may be helpful to anyone involved in the selection process.

DIFFERENT POINTS OF VIEW: Some educators and other professionals have suggested that use of technology may not be the best way to enhance reading instruction.

Discussing the possibility that electronic texts eventually will take precedence over the printed page, Birkets (1994) laments the repercussions for young readers. He denotes the comfort and connection in physically handling and slowly reading a printed book, and says that these qualities are lost when text is instantly transmitted electronically by the click of a mouse. "Electronic books and interactive videos will leach away our capacities for reflection," he states (p. 144). Birkets also notes that electronic texts and hypertext may promote "a reduced attention span and a general impatience with sustained inquiry" among children (p. 27). Although acknowledging the value of audiobooks (he says they "remind us of the sound of literature," p. 149), Birkets thinks that children are better served when adults read aloud to them, thus providing opportunities for spontaneous questions and verbal interaction.

Wood (2000) notes that software programs for the teaching of vocabulary may not be instructionally sound if they focus on having students merely match words and definitions: "Without presenting words in multiple contexts, students' understanding of those words is limited to the narrow context suggested by the software—preventing students from truly 'owning' a word in all its multiple nuances and meanings, which vocabulary experts say is necessary if students are to actually feel comfortable using new words" (p. 123).

Comparing reading a book and reading on an electronic screen, Healy (1998) notes some problems generated from electronic texts. "Reading from a screen is slower, more fatiguing, less accurate, and more subject to information overload than standard reading," she states. "In several studies, students tested for comprehension after reading from a screen demonstrated less understanding and poorer memory than those getting the same information from a book" (p. 152).

The Alliance for Childhood (2000) has warned about potential problems resulting from young children's overuse of computers. Its report, Fool's Gold: A Critical Look at Computers in Childhood, raises concerns that children using computers may suffer from "repetitive stress injuries, eyestrain, obesity, [and] social isolation." With regard to literacy in particular, the report states, "Computer use places added strain on a child's eyes and developing visual

system, and may actually make learning to read more of a challenge for young children." The report also suggests that reading books on the computer may actually discourage literacy: "Some teachers report that the animation and other multimedia features of electronic books are so visually diverting that they actually distract children from the story."

ILLUSTRATIVE CASES:

- The writing of students at University Park Elementary School in Fairbanks, Alaska, is available through the school's World Wide Web Storybook Library.
- At the International School of Amsterdam in the Netherlands, technology is used to enrich students' reading and writing skills through development of Web-based collaborative projects. Ms. Hos-McGrane's Grades 5 and 6 student projects on the Web shows examples of students' written work, including their research and stories about puppets, original folktales written after gathering and reading folktales from around the world, and stories about their grandparents.
- The third-grade classes at Willard Elementary School in Minneapolis learned about the editing process through outlines, rough drafts, and final drafts. They developed a Web site that showcases third-grade student work.
- The Accelerated Learning Laboratory School, a K-12 magnet school in Worcester, Massachusetts, uses technology to promote literacy. Teachers focus on teaching the basics through software programs emphasizing spelling, letter recognition, rhyming words, word processing, and collaborative writing.
- At the Educational Video Center, located in a public high school in New York City, at-risk urban students work together to produce videos on issues such as poverty and racism. In the process, they learn to write multiple drafts, reflect, revise, and submit work to peer review.
- The Flat Stanley Project is an international writing and communication activity designed for primary and intermediate-grade students. Created by Dale Hubert, a third-grade teacher in London, Ontario, Canada, the project encourages students to read the book *Flat Stanley*, written by Jeff Brown (1996), and participate in regular mail and e-mail literacy-building activities.

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http://www.ncrel.org/sdrs/areas/issues/content/cntareas/reading/li300.htm

WWW: http://www.reading.org/

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References

Date posted: October 2001

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